Biomedical Image Transmission over ATM (BITA Project)

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Who is the Communications Engineering Branch (CEB)?
[Web site URL http://archive.nlm.nih.gov]

- Part of the Lister Hill National Center for Biomedical Communications, a research arm of the NLM

- 18 Engineer/Computer scientists at CEB

- Projects deal with document images, digital x-ray images, Visible Human color images; image archiving, processing, enhancement; and communications engineering

Why is CEB involved with ATM?

■ ISTO: Image Storage Transmission and Optimization Project (compression and communications techniques applied to Visible Human data set): *Need faster data transfer*

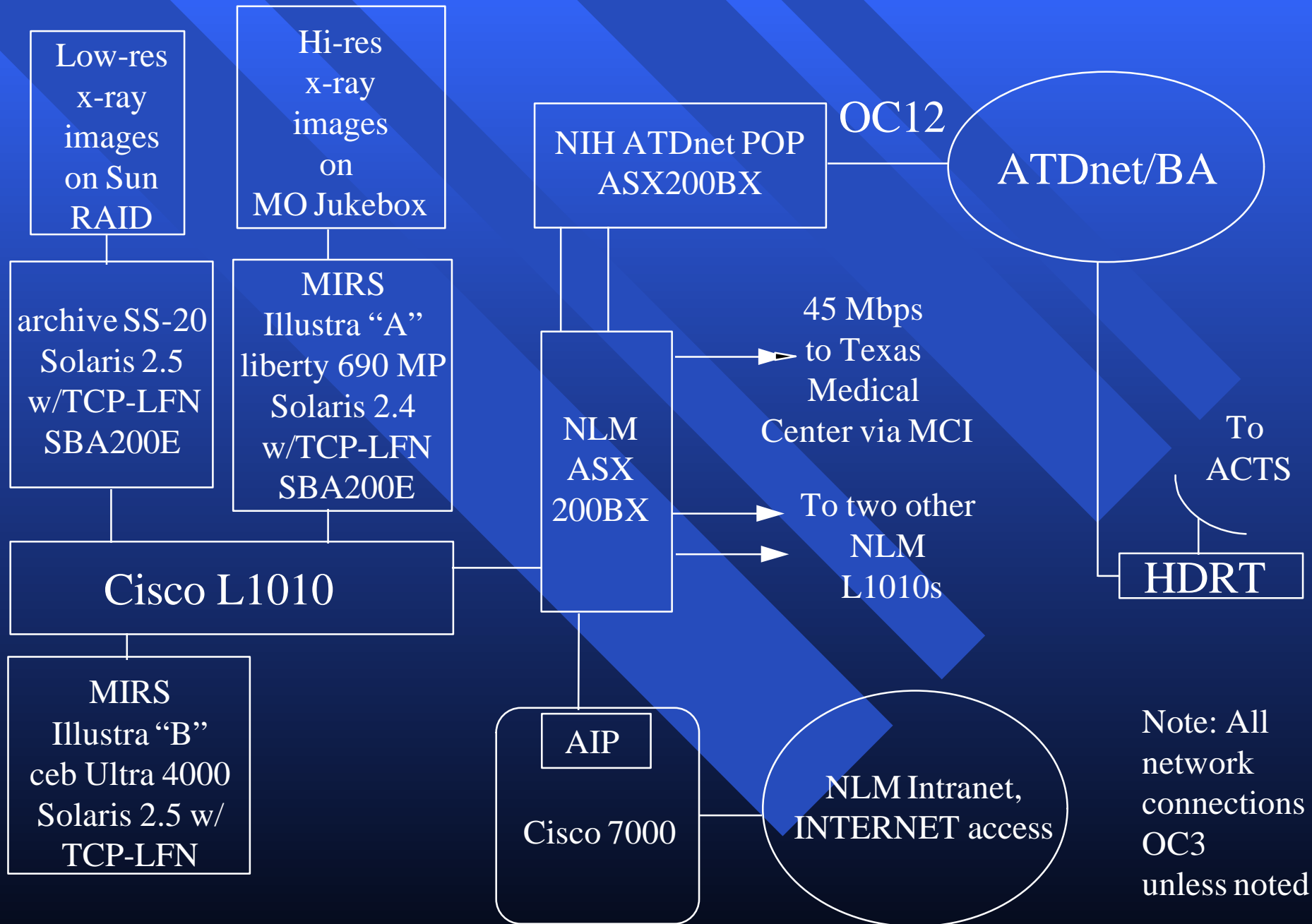– BITA (sub-project): Biomedical transmission over ATM

BITA current focus

- **Access to Biomedical Databases over High Speed Satellite Link**

- **Goals**

    - Evaluate alternative methods for efficient delivery of TCP data in a high-speed ATM environment with and without geosynchronous delay

    - Evaluate performance of client/server applications which provide mixed image/text database query capability with and without geosynchronous delay
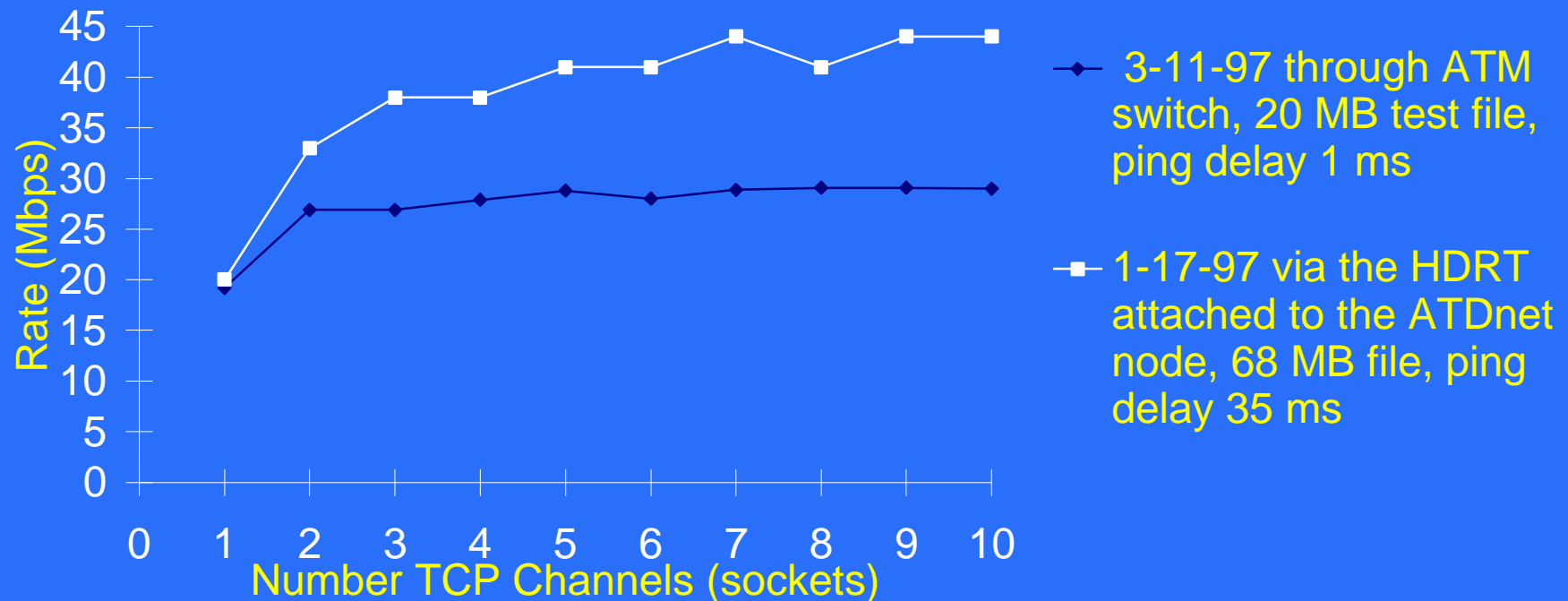
ATM Research Network Connectivity

- ATDnet: Advanced Technology Demonstration Network
  - NLM has 2 155 Mbps links into the ATDnet
    - » Via an NIH 622 Mbps link to ATDnet
- MCI technology trial network
  - NLM has a 45 Mbps link into an MCI ATM test network
    - » Texas Medical Center at other end of link, through the Institute for Biosciences and Technology (part of TAMU:Texas A&M University)
- When/Which ATM at NLM
  - First ATM switches bought end FY'95
  - 2 Fore Systems ASX200BXs, 3 Cisco Lightstream L1010s

NLM-AAMnet ATM Testbed

Low-res x-ray images on Sun RAID

Hi-res x-ray images on MO Jukebox

NIH ATDnet POP ASX200BX — OC12 — ATDnet/BA

archive SS-20 Solaris 2.5 w/TCP-LFN SBA200E

MIRS Illustra "A" liberty 690 MP Solaris 2.4 w/TCP-LFN SBA200E

NLM ASX 200BX

45 Mbps to Texas Medical Center via MCI

To two other NLM L1010s

To ACTS

Cisco L1010

HDRT

MIRS Illustra "B" ceb Ultra 4000 Solaris 2.5 w/ TCP-LFN

AIP

Cisco 7000

NLM Intranet, INTERNET access

Note: All network connections OC3 unless noted

BITA-Very Preliminary Results

File transfer rates over ATM
(Mem-to-mem, CIP, in-house machine-to-in-house machine)

Rate (Mbps) vs Number TCP Channels (sockets)

- 3-11-97 through ATM switch, 20 MB test file, ping delay 1 ms
- 1-17-97 via the HDRT attached to the ATDnet node, 68 MB file, ping delay 35 ms

BITA-Very Preliminary Results

File transfer rates over ATM
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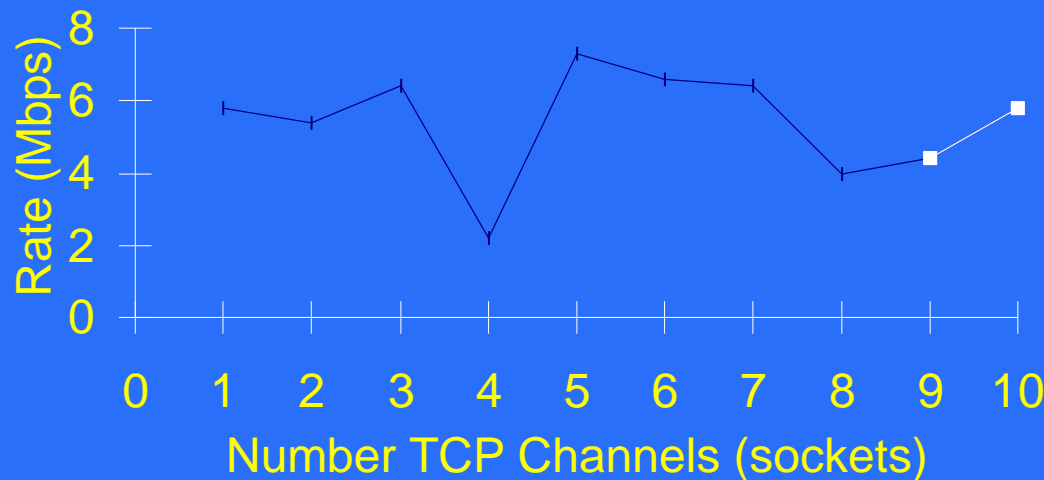
— 3-12-97 via the HDRT using simulated satellite circuit, ping delay 539 ms

— 1-24-97 via loopback at the ACTS, ping delay 549 ms

Data sets

■ What digitized biomedical images/data sets exist here?

- NHANES II (spine x-ray images)
- Visible Human (MRI, CT, Cryosectioned anatomic color images)
- Possible future images: NHANES III (hands, knees x-ray images)

NHANES II

■ Collateral data and x-rays from the 1976-1980 National Health and Nutrition and Examination Survey (NHANES II)

■ Gathered by National Center for Health Statistics (NCHS), part of the Centers for Disease Control in Hyattsville, Maryland

■ X-rays digitized under contract to NCHS

■ Work done in collaboration with National Institute of Arthritis and Musculoskeletal and Skin Diseases

NHANES II

- About 17,000 digitized x-rays of lumbar and cervical regions

- Cross section of United States population

- Lateral views of cervical and lumbar spine for persons age 25-74

- 300 platters total, 100-140 GB data set

- Part of uncompressed image data on 144 5.25" magneto-optical platters in a jukebox

- Digitized using either a Lumisys 100 or 150 laser spot scanner/spot size 150 microns

- Cervical resolution of 1463x1755x12 bits, (5 MB)

- Lumbar resolution of 2048x2487x12 bits, (10 MB)

Visible Human

- Data set representing complete normal adult male and female
- MRI, CT and cryosectioned anatomical images of two cadavers
- Male and female data provided to over 700 licensees
- Male Dataset
  - MRI: axial images of head and neck and longitudinal of rest of body at 4 mm intervals, 256x256x12 bits gray scale
  - CT: Axial scans of entire body at 1 mm intervals at 512x512x12 bits grey scale
  - Anatomical cryosection (ccd scanned): Axial images at *1 mm* intervals at 2048x1216x24 bits color (bulk of dataset)
  - 1871 cross-sections for each mode
  - Complete male set 15 GB

Visible Human

- Female Dataset
  - MRI: axial images of head and neck and longitudinal of rest of body at 4 mm intervals, 256x256x12 bits gray scale
  - CT: Axial scans of entire body at 1 mm intervals at 512x512x12 bits grey scale
  - Anatomical cryosection (ccd scanned) : Axial images at *.33 mm* intervals at 2048x1216x24 bits color as opposed to *1 mm* for male (bulk of dataset)
    - » Result is 5000 cross-sections
  - Complete female set 40 GB

Demonstrations involving BITA

- **_Past_**

  RSNA Chicago December 1996

- Future

  - 1997 Joint Meeting of the Public Health Conference on Records and Statistics and the Data Users Conference
    - » Washington DC July 28-31, 1997
    - » MIRS and WebMIRS
    - » Via ATDnet at OC3 rate

RSNA Demonstration

- First live video and audio over ATM from NLM December 1996

- Broadcast to MD Anderson booth at RSNA

- Collaboration with Don Schomer of MD Anderson, Leland Ellis of IBT/TAMU, Larry Flournoy of ISC/TAMU, Dave Beering of ARIES/API and many others

NLM RSNA Demonstration
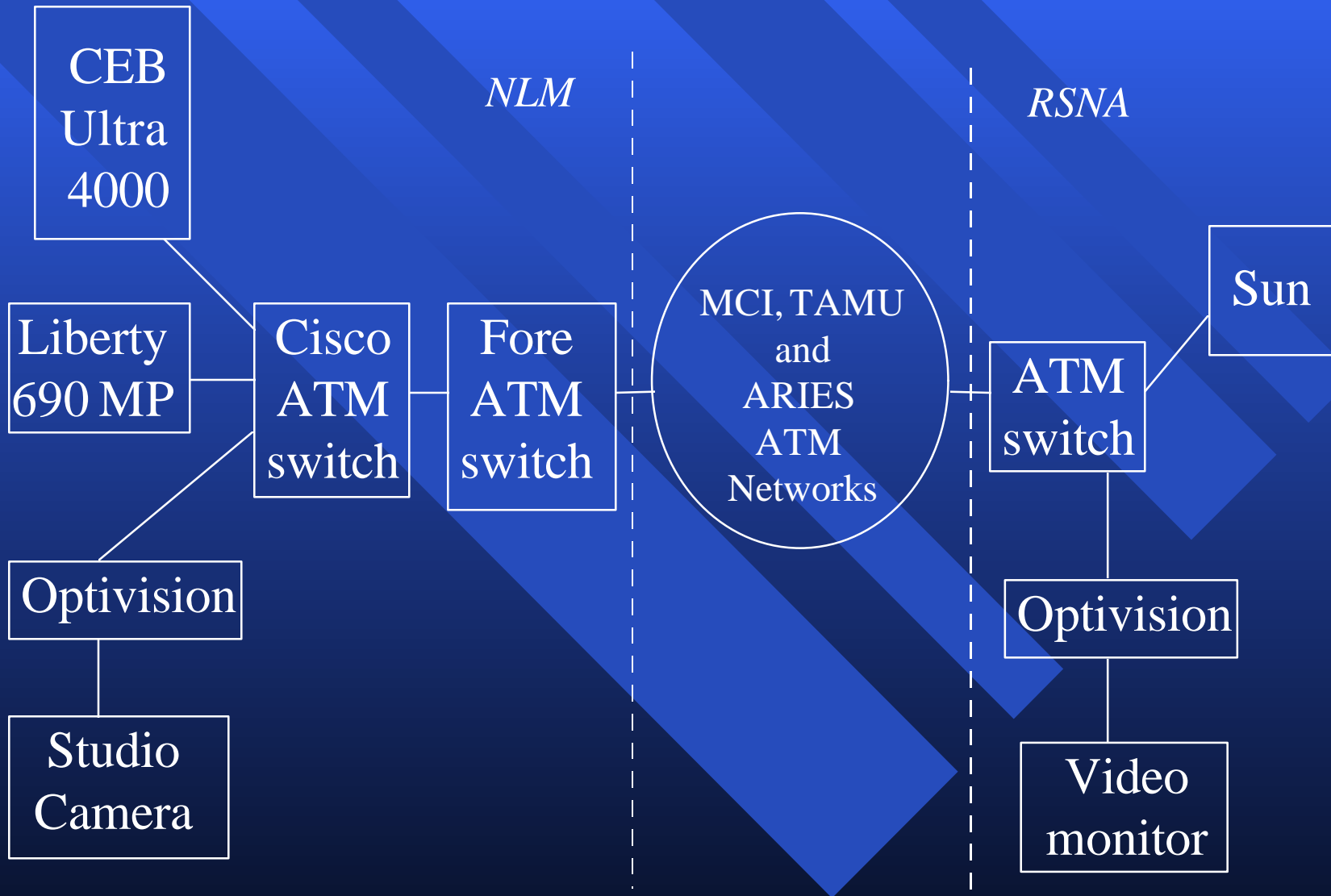
RSNA demonstration

- Utilized MCI, TAMU and ARIES research networks
- Taped video: explanation of use and reason for NHANES by NLM and NCHS/NIAMS collaborators
  - Initially planned for live
  - Went to taped due to line outage between Houston and Chicago
  - Live video Q and A session between NLM and RSNA attendees after tape was transmitted/viewed in Chicago

RSNA Demonstration

- First demonstration of in-house MIRS (Medical Image Retrieval Software) client-server software via TCP/IP over ATM
    - MIRS client accessed x-ray images here at NLM
    - WebMIRS, a JAVA applet, accessed NHANES II x-rays via Netscape stored here at NLM

- Equipment used
    - Optivision MPEG II encoder/decoder at each location
    - Used 3 Mbps transmit video/audio NLM to RSNA (via 1 PVC)
    - Used 1 Mbps to transmit video/audio RSNA to NLM (via same PVC)
    - Studio quality camera at NLM
    - Consumer grade camcorder at RSNA

ATM Telemedicine Benefits/Barriers

- BENEFITS
    - Enhanced access to biomedical image research data
    - Wider distribution of data (ATM used in the telecommunications system infrastructure)
    - Higher resolution image datasets (larger image files allow for lossless images)
    - Enhances accessibility of multimedia (text and images) databases
    - Faster network access
- BARRIERS
    - Lack of native ATM applications
    - Slow adoption rate of ATM technology
    - Few management tools for ATM networks

NLM team members,
references and acknowledgments

- NLM Team members: Dr. George Thoma, CEB Branch Chief, Rodney Long, Jules Aronson.
- NLM- http://www.nlm.nih.gov, CEB- http://archive.nlm.nih.gov
- AAMnet- http://www.cgrg.ohio-state.edu/other/actsgsn/aamexp.html
- Numerous parties enable(d) this work to move forward including but not limited to
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  - TAMU: Leland Ellis, Larry Flournoy, Andrew Jackson/ IBT/TAMU team
  - INDUSTRY: Dave Beering ARIES/API , Ed Singer/ATDnet Bell Atlantic Operations manager, Amir Ansari/MCI, John Williams/Fore Federal Healthcare Systems , Reed Majors/Optivision, Dave Brigati/Cisco Systems, Inc.
  - MD Anderson: Don Schomer, M.D.